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Publication date
2023

Document Version
Final published version

Citation (APA)
Versluis, N. D., Pellegrini, P., Quaglietta, E., Goverde, R. M. P., & Rodriguez, J. (2023). *A MILP-Based Railway Conflict Detection and Resolution Model Approximating Moving-Block Signalling*. Abstract from International Conference on Optimization and Decision Science 2023, Ischia, Italy.

A MILP-Based Railway Conflict Detection and Resolution Model Approximating Moving-Block Signalling

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Abstract Railway industry is developing advanced signalling systems like moving block to improve network capacity. In traditional fixed-block systems, safe train separation is determined based on a fixed number of block sections representing worst-case braking distances. In moving-block systems, the train separation is reduced to absolute braking distances. The introduction of moving-block signalling requires a change in operational rules and hence in real-time conflict detection and resolution methods in case of disturbances. Existing conflict detection and resolution models are mainly based on fixed-block signalling and the available models for moving-block signalling do not sufficiently represent the dynamic relation between safe train separation and actual train speeds. To address this gap, we propose a conflict detection and resolution model that approximates moving-block operations. The model enhances the state-of-the-art fixed-block model RECIFE-MILP [1]. The enhancements include a reconsideration of the discretisation of the infrastructure, the introduction of a speed profile alternative and a redefinition of blocking times. With this, the model is able to include speed-dependent occupation times, train separation based on absolute braking distances and continuous braking curve supervision. We present the reformulated MILP (mixed integer linear programming) model and apply it to two French case studies: the Gonesse junction and a part of the Paris-Le Havre line. For various one-hour periods, rescheduling strategies and disturbance scenarios, we compare the optimal solutions of the enhanced and the original RECIFE-MILP model in terms of total train delay and rescheduling decisions. The results show that the enhanced model can propose different rescheduling decisions than the original model, with a better delay recovery exploiting the moving-block system. This research is funded

by the Shift2Rail Joint Undertaking under grant agreement No. 101015416 (PERFORMINGRAIL).

Keywords: railway traffic management, conflict detection and resolution, train rescheduling, moving-block signalling, mixed integer linear programming

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[1] P. Pellegrini, G. Marlière, R. Pesenti and J. Rodriquez, RECIFE-MILP: An Effective MILP-Based Heuristic for the Real-Time Railway Traffic Management Problem, IEEE Transactions on Intelligent Transportation Systems, 16(5), 2609-2619, 2015.